Uh

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/731,520	12/09/2003	Brian Paul Gaucher	YOR920030232US1 (8728-630	3725

7590 04/22/2005

Frank Chau
F. CHAU & ASSOCIATES, LLP
Suite 501
1900 Hempstead Turnpike
East Meadow, NY 11554

EXAMINER	
ALEMU, EPHREM	

ART UNIT	PAPER NUMBER
2821	

DATE MAILED: 04/22/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/731,520	GAUCHER ET AL.	
	Examiner	Art Unit	
	Ephrem Alemu	2821	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _09 December 2003_.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _1-38_ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _1-38_ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _12-09-03_.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☒ Other: _See Continuation Sheet_.

Continuation of Attachment(s) 6). Other: The ARRL Antenna Book pages 2-23 to 2-25.

DETAILED ACTION

Specification

1. The specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

2. The disclosure is objected to because of the following informalities: In page 2, lines 21, replace "which is are" with --which are--. Appropriate correction is required.

Claim Objections

3. Claims 12, 15 are objected to because of the following informalities: In claim 12, line 2, change "a IC" with --an IC--; in claim 15, line 3, "a insulation" with --an insulation--; . Appropriate correction is required.

4. The numbering of claims is not in accordance with 37 CFR 1.126 which requires the original numbering of the claims to be preserved throughout the prosecution. When claims are canceled, the remaining claims must not be renumbered. When new claims are presented, they must be numbered consecutively beginning with the number next following the highest numbered claims previously presented (whether entered or not).

Misnumbered claims 22-39 has been renumbered as claims 21-38 since the original claims as filed does not include "claim 21".

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

6. Claims 1, 2, 7, 9 and 10 are rejected under 35 U.S.C. 102(b) as being anticipated by Siwiak et al. (5,410,749).

Re claims 1, 2, 7, 9 and 10, Siwiak discloses a wireless device (i.e., a radio communication) comprising antenna (300), the antenna (300) comprising:

a substrate (i.e., dielectric material 304) (Fig. 2; abstract; Col. 3, lines 23-54);

ground plane (314) formed on a surface of the substrate (i.e., dielectric material 304) (Fig. 2; abstract; Col. 3, lines 23-54); and

at least one radiating element (hat element) (302) formed on one end of a conductive via stub (i.e., feeders 308, 310 extending through apertures 316, 312 and conductive shorting element 306 extends through an aperture 313) formed in the substrate (i.e., dielectric material 304) (Figs. 2, 3; abstract; Col. 3, lines 23-59).

7. Claims 1, 11, 12, 22, 23 and 24 are rejected under 35 U.S.C. 102(b) as being anticipated by Takahashi et al. (5,903,239).

Re claims 1, 11, 12, 22, 23 and 24, Takahashi discloses an integrated communications device (i.e., antenna apparatus) comprising:

an IC (integrated circuit) chip (i.e., circuit chip 52) (Fig. 3; Col. 4, lines 3-37); and

an antenna (i.e., antenna chip 54) bonded to the IC chip (i.e., circuit chip 52), the antenna (i.e., antenna chip 54) comprising:

a substrate (9) (Fig. 3); and

at least one radiating element (hat element) (i.e., microstrip patch antenna 10, 19) comprising conductive via stub (i.e., through hole 11) formed in the substrate (9) (Figs. 3, 8; abstract; Col. 1, lines 5-17; Col. 4, lines 3-37; wherein the IC chip comprises a transceiver, a receiver, or a transmitter; and wherein the dielectric layer of the antenna acts as a cover for the integrated device (see Fig. 8)).

8. Claims 1, 4, 5, 12-20, 23, 25, 26-33 and 34-38 are rejected under 35 U.S.C. 102(b) as being anticipated by Araki et al. (5,400,039).

Re claims 1, 4, 5, 12, 13, 14, 15, 16, 17, 18, 19, 20, 23 and 25, Araki discloses an integrated communications device (i.e., a mobile communication system having integrated multilayered microwave circuit) (Figs. 1-3, 14-19) comprising:

an IC (integrated circuit) chip (i.e., communication portion 27) (Figs. 1-3, 5-8, 14-19; Col. 4, lines 3-37); and

an antenna (i.e., antenna portion 21) bonded to the IC chip (i.e., communication portion 27) (Figs. 1-3; 14-19; Col. 3, lines 48-62; Col. 6, lines 23-47; Col. 12, lines 16-26; Col. 13, lines 17-60; wherein the antenna is an omni-directional antenna or a directional antenna), the antenna (i.e., antenna portion 21) comprising:

a substrate (i.e., dielectric layers 4, 6, 14) (Figs. 1-3, 14-19; Col. Col. 6, lines 23-47; Col. 13, lines 17-24);

at least one radiating element (i.e., radiator 22, 23, 24 as form of a hat element) comprising conductive via stub (i.e., via conductor 2a as a form of feeding via to provide connection to the antenna) formed in the substrate (i.e., dielectric layers 4, 6, 14);

a plurality of patterned layers (i.e., conductive layers 1, 3, 12, 17) comprising a ground plane (i.e., grounding layer 3) formed on a surface of the substrate (i.e., dielectric layer 14) of the antenna (i.e., antenna portion 21); an insulation layer formed on the ground plane; the plurality of patterned layers (i.e., conductive layers 1, 3, 12, 17) formed between the antenna (i.e., antenna portion 21) and IC chip (i.e., communication portion 27) for providing electrical interconnections (i.e., dielectric layers 4, 6, 14);

impedance matching network that formed from the plurality of patterned layers comprises a microstrip transmission line (Figs. 1-3, 14-19; Col. 3, lines 48-62; Col. 6, lines 23-47; Col. 13, lines 17-60; Col. 15, 11-14; wherein the IC chip (i.e., communication portion 27) comprises a transceiver, a receiver, or a transmitter; wherein a grounding via (13) is provided for ground connections between the IC chip (i.e., communication portion 27) and the ground plane (i.e., grounding layer 3) of the antenna.).

Re claims 26-33 and 34-48, given Araki's integrated communications device (i.e., a mobile communication system having integrated multilayered microwave circuit) as described above in claims 1, 4, 5, 12, 13, 14, 15, 16, 17, 18, 19, 20, 23 and 25, the method for constructing an antenna and/or an integrated communication apparatus as claimed in claims 26-33 and/or 34-38 is inevitable.

9. Claims 1-3 and 7-10 are rejected under 35 U.S.C. 102(e) as being anticipated by Chen (US 6,809,689).

Re claims 1, 3, 7 and 10, Chen discloses a wireless device (i.e., portable electronic apparatus (6) including an antenna (100) (Figs. 2-5), the antenna (100) comprising:

a substrate (1); and

at least one radiating element (hat) (2) formed on one end of a conductive via stub (i.e., conductive vias 13, 14) formed in the substrate (1) (Figs. 2-5; Col. 3, lines 1-11).

Re claim 2, Chen further discloses a ground plane (i.e., grounding metal layer 4) formed on a surface (12) of the substrate (1) (Figs. 2-5; Col. 3, lines 30-38; wherein the antenna (10) is an omni-directional antenna (see Figs. 7-10)).

Re claims 8 and 9, Chen further discloses the dielectric substrate is a printed circuit board (Figs. 2-5; abstract; Col. 3, 1-3).

Claim Rejections - 35 USC § 103

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

11. Claims 6 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takahashi (US 5,903,239) in view of The ARRL antenna book (pages 2-24 to 2-25).

Re claims 6 and 21, Takahashi discloses the claimed limitations as described above in claims 1 and 12, except the antenna having resonant frequency of about 20 GHz.

However, The ARRL antenna book discloses that any antenna design can be scaled in size for use in another frequency.

It would have been in the skill of an artisan at the time the invention was made to scale the size of Takahashi antenna as taught in the ARRL antenna book for the purpose of operating the antenna in about 20 GHz or greater.

Conclusion

12. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Yamada (US 6,809,688); Masuda (6,404,395); and Sakota et al. (US 6,388,623); teach similar inventive subject matter.

Correspondence

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ephrem Alemu whose telephone number is (571) 272-1818. The examiner can normally be reached on M-F Flex hours.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Don K Wong can be reached on (571) 272-1834. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

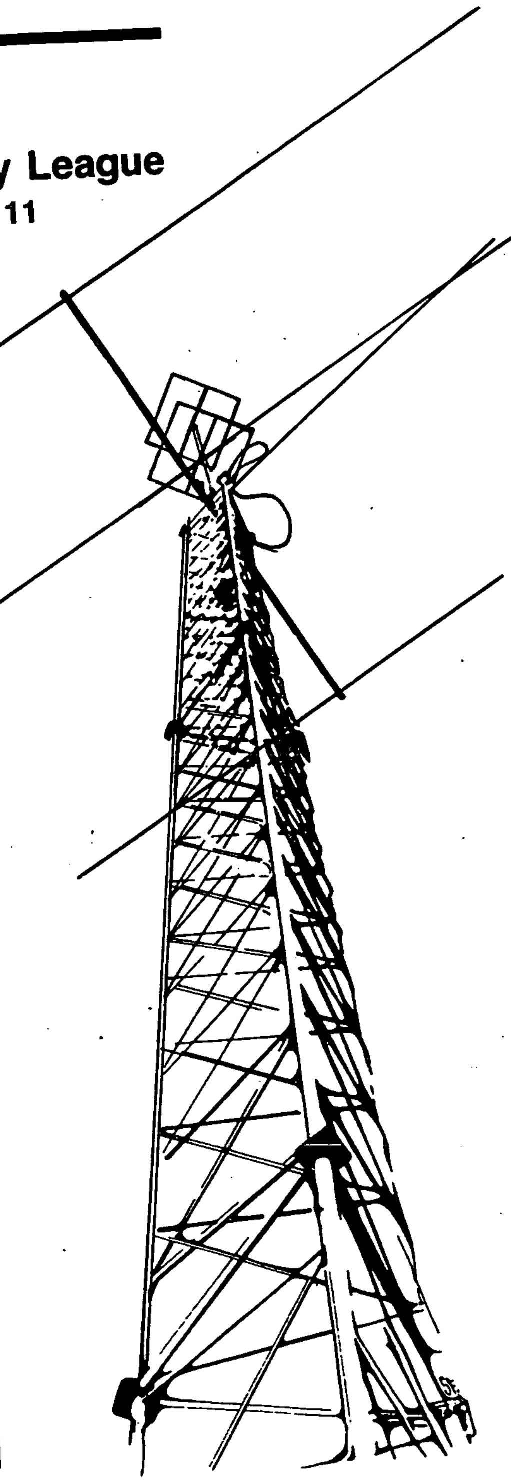
Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

EA
4-01-05

TUYET VO
PRIMARY EXAMINER

The ARRL Antenna Book

Published by
The American Radio Relay League
Newington, CT USA 06111



Editor
Gerald (Jerry) Hall, K1TD

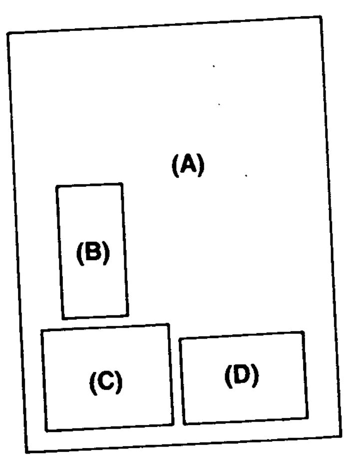
Associate Editor
James W. Healy, NJ2L

Assistant Editors
Bruce S. Hale, KB1MW
Charles L. Hutchinson, K8CH
Mark J. Wilson, AA2Z
Larry Wolfgang, WA3VIL

Contributing Authors
John Almeida, KA1AIR
Wilfred N. Caron
Steve Cerwin, WA5FRF
Roger A. Cox, WBØDGF
Philip V. D'Agostino, W1KSC
Richard Guski, KC2MK
Robert (Ted) Hart, W5QJR
F. Robert Hawk, KØYEH
John Kraus, W8JK
Roy W. Lewallen, W7EL
Domenic M. Mallozzi, N1DM
Jim McKim, WØCY
William T. Schrader, K2TNO
Ralph Shaw, K5CAV
Allan White, W1EYI
Thomas Willeford, N8ETU

Contributors
Chip Angle, N6CA
Bob Atkins, KA1GT
Thomas A. Beery, WD5CAW
Dennis Bodson, W4PWF
Bruce Brown, W6TWW
Warren Bruene, W5OLY
Robert E. Cowan, K5QIN
Dave Fisher, WØMHS
Donald K. Johnson, W6AAQ
M. Walter Maxwell, W2DU
Charles J. Michaels, W7XC
Bill Myers, K1GQ
Jack Sobel, WØSVM
John J. Uhl, KV5E
Brian L. Wermager, KØEOU
Frank J. Witt, AI1H
Deane J. Yungling, KI6O

Production
Leslie Bartoloth, KA1MJP
Laird Campbell, W1CUT
Michelle Chrisjohn, WB1ENT
Sue Fagan, cover
Alison Halapin
Mark Kajpust
Joel Kleinman, N1BKE
Steffie Nelson, KA1IFB
David Pingree
Jean Wilson



A—Photo of 120-foot tower at W1AW by Meyers Studio. Moon photo courtesy Chuck Hutchinson, K8CH

B—Photo courtesy Bob Cutter, KIØG

C—30-foot polar-mount dish at K5AZU

D—12 17-element long-boom 2-meter Yagis at N5BLZ

This work is publication No. 15 of the Radio Amateur's Library, published by the League.

Printed in USA

Library of Congress Catalog Card Number: 55-8966

$18.00 in USA

15th Edition

ISBN: 0-87259-206-5

Table 2
Voltage Ratio to Decibel Conversion

	Decimal Increments									
Ratio	*0.0*	*0.1*	*0.2*	*0.3*	*0.4*	*0.5*	*0.6*	*0.7*	*0.8*	*0.9*
1	0.00	0.83	1.58	2.28	2.92	3.52	4.08	4.61	5.11	5.58
2	6.02	6.44	6.85	7.23	7.60	7.96	8.30	8.63	8.94	9.25
3	9.54	9.83	10.10	10.37	10.63	10.88	11.13	11.36	11.60	11.82
4	12.04	12.26	12.46	12.67	12.87	13.06	13.26	13.44	13.62	13.80
5	13.98	14.15	14.32	14.49	14.65	14.81	14.96	15.12	15.27	15.42
6	15.56	15.71	15.85	15.99	16.12	16.26	16.39	16.52	16.65	16.78
7	16.90	17.03	17.15	17.27	17.38	17.50	17.62	17.73	17.84	17.95
8	18.06	18.17	18.28	18.38	18.49	18.59	18.69	18.79	18.89	18.99
9	19.08	19.18	19.28	19.37	19.46	19.55	19.65	19.74	19.82	19.91
10	20.00	20.09	20.17	20.26	20.34	20.42	20.51	20.59	20.67	20.75
× 10	+20									
× 100	+40									
× 1000	+60									
× 10,000	+80									
× 100,000	+100									

an increase in field strength in its most favored direction over a ½-λ dipole in *its* most favored direction, when both antennas are supplied with the same amount of power.

The power gain from harmonic operation is small when the antenna is small in terms of wavelengths, but is quite appreciable when the antenna is fairly long. The theoretical power gain of harmonic antennas or "long wires" is shown by curve B in Fig 8, using the ½-λ dipole as a reference. A 1-λ or "second harmonic" antenna has only a slight pc gain, but an antenna 9 λ long shows a power gain of ne 7 dB over the dipole. This gain occurs in one directio reducing or eliminating the power radiated in other directi thus the longer the wire, the more directive the ant becomes. Curve A in Fig 8 shows how the radiation resist (as measured at a current loop) varies with the length harmonic antenna.

Antenna Frequency Scaling

Any antenna design can be scaled in size for use on another frequency or on another amateur band. The dimensions of the antenna may be scaled with Eq 1.

$$D = \frac{f1}{f2} \times d \qquad \text{(Eq 1)}$$

where
D = scaled dimension
d = original design dimension
f1 = original design frequency
f2 = scaled frequency (frequency of intended operation)

From this equation, a published antenna design for, say, 14 MHz, can be scaled in size and constructed for operation on 18 MHz, or any other desired band. Similarly, an antenna design could be developed experimentally at VHF or UHF and then scaled for operation in one of the HF bands. For example, from Eq 1, an element of 39.0 inches length at 144 MHz would be scaled to 14 MHz as follows: D = 144/14 × 39 = 401.1 inches, which is the same as 33.43 feet.

To scale an antenna properly, *all* physical dimensions must be scaled, including element lengths, element spacings, boom diameters, and *element diameters*. Lengths and spacings may be scaled in a straightforward manner as in the above example, but element diameters are often not as conveniently scaled. For example, assume a 14-MHz antenna is m at 144 MHz and perfected with 3/8-inch cylindrical ele For proper scaling to 14 MHz, the elements sho cylindrical, of 144/14 × 3/8 or 3.86 inches diameter. a realistic standpoint, a 4-inch diameter might be acce but cylindrical elements of 4-inch diameter in leng 33 feet or so would be quite unwieldy (and quite expe Choosing another, more suitable diameter is the only p answer.

DIAMETER (RADIUS) SCALING

Simply changing the diameter of dipole type e during the scaling process is not satisfactory without a corresponding element length correction. This is changing the diameter results in a change in the λ/d from the original design, and this alters the corres resonant frequency of the element. In effect, the length must be corrected by applying a different K fa discussed in connection with Fig 3 early in this ch

To be more precise, however, the purpose of scaling is not to maintain the same resonant frequ the element, but to maintain the same *reactanc operating frequency*. As a matter of fact, for elem are not resonant at the operating frequency in the design, the ratio of the two resonant frequencies (b

after scaling) will not equal the scaling ratio, f1/f2, as defined for Eq 1. This is because the reactance varies at a different rate with frequency changes for different λ/dia elements. In other words, looking at the two elements as two resonant circuits, the Qs are different.

Necessary length corrections may be determined from Eqs 2 through 7 below. The calculations yield the proper length for a given element with a newly assigned diameter. For simplification, all dimensions are treated in wavelengths, rather than in physical units. Therefore, some values will be handled as quite small decimal fractions. The information which follows is adapted from Chapter 7 of the book by Jim Lawson, W2PV, *Yagi-Antenna Design* (see bibliography at the end of this chapter). The procedure may be performed with a scientific electronic calculator, but such calculations are somewhat tedious. A programmable calculator or a personal computer relieves the tedium. The following equations are used in the calculations. Their use is explained after all equations and definitions are presented. In the equations and procedure that follows, the suffix designator 1 indicates the *original* design, and 2 the *scaled* design.

$$M = \log \frac{2}{d} \qquad \text{(Eq 2)}$$

$$A = 430.8\,M - 339 \qquad \text{(Eq 3)}$$

$$\ell R = 0.5 - \frac{33.25 + 3.19M - 0.35M^2}{861.6 - 678} \qquad \text{(Eq 4)}$$

$$FR1 = \frac{\ell R1}{\ell 1} \qquad \text{(Eq 5)}$$

$$FR2 = 1 - \frac{A1\,(1 - FR1)}{A2} \qquad \text{(Eq 6)}$$

$$\ell 2 = \frac{\ell R2}{FR2} \qquad \text{(Eq 7)}$$

where

M = a constant related to the λ/dia of the element
d = element diameter in wavelengths
A corresponds to the slope of the reactance curve of the element
ℓR = approximate resonant length of element in wavelengths
FR = approximate resonant frequency of element, normalized to the design frequency
ℓ = element length in wavelengths
λ = free-space wavelength

The first few steps of the scaling procedure determine constants for the original design. Then the scaled length is calculated for the new diameter. Step by step instructions follow, after which an example is given. Remember, the suffix designator 1 indicates the original design, and the designator 2 the scaled design.

1) Determine d1, the original element diameter in free-space wavelengths. A free-space wavelength is $983.6/f_{MHz}$ feet or $11803/f_{MHz}$ inches.
2) Determine ℓ1, the element length in free-space wavelengths.
3) Determine M1 from Eq 2.
4) Determine A1 from Eq 3.
5) Determine ℓR1 from Eq 4.
6) Determine FR1 from Eq 5.
7) Assign d2 in free-space wavelengths.
8) Determine M2 from Eq 2.
9) Determine A2 from Eq 3.
10) Determine ℓR2 from Eq 4.
11) Determine FR2 from Eq 6. Use algebraic subtraction.
12) Determine ℓ2 from Eq 7. This is the scaled element length for the new diameter, in wavelengths. Convert this value to a physical length for the scaled frequency.

A Diameter Scaling Example

Earlier in this section we saw that a 3/8-inch diameter element of length 39 inches for 144 MHz, scaled to 14 MHz, would have a diameter of 3.86 inches and length 401.1 inches. A more practical element diameter would be 7/8 inch. The correct element length for this diameter is found by following the 12 steps outlined above. Five significant digits are used in working through this example; the results are rounded to four.

From step 1, determine d1, the original (144 MHz) element diameter in wavelengths. The free-space wavelength for this frequency is 11803/144 or 81.965 inches. For a 3/8-inch dia element, d1 = (3/8)/81.965 = 0.0045751 λ. From step 2, the element length ℓ1 = 39/81.965 = 0.47581 λ.

From step 3 and Eq 2, M1 = log (2/0.0045751) = 2.6406. From step 4 and Eq 3, A1 = 430.8 × 2.6406 − 339 = 798.57.

From step 5 and Eq 4,

$$\ell R1 = 0.5 - \frac{33.25 + 3.19 \times 2.6406 - 0.35 \times 2.6406^2}{861.6 \times 2.6406 - 678}$$

$$= \frac{39.233}{1597.1} = 0.47543$$

Next, from step 6 and Eq 5, FR1 = 0.47543/0.47581 = 0.99920. This completes the calculation of constants for the original design.

For the scaled design, from step 7 we determine d2 in wavelengths. A free-space wavelength at 14 MHz is 11803/14 or 843.07 inches. From this, for a 7/8-inch diameter, d2 = (7/8)/843.07 = 0.0010378 λ. From step 8 and Eq 2, M2 = log (2/0.0010378) = 3.2849. From step 9 and Eq 3, A2 = 430.8 × 3.2849 − 339 = 1076.1.

From step 10 and Eq 4,

$$\ell R2 = 0.5 - \frac{33.25 + 3.19 \times 3.2849 - 0.35 \times 3.2849^2}{861.6 \times 3.2849 - 678}$$

$$= 0.48144$$

From step 11 and Eq 6,

$$FR2 = 1 - \frac{798.57\,(1 - 0.99920)}{1076.1} = 0.99941$$

From step 12 and Eq 7, ℓ2 = 0.48144/0.99941 = 0.48172 λ. This is the scaled element length in wavelengths. Multiplying by the dimension of one wavelength at 14 MHz obtains the physical length; 843.07 × 0.48172 = 406.1 inches or 33.84 feet. (As a matter of interest, this is 5.0 inches longer than that calculated earlier for a diameter of 3.86 inches.)

Consequences of Diameter Scaling

An antenna for which *all* dimensions are scaled up or down to operate on a new frequency should behave exactly the same way as the original. In other words, the feed-point impedance, gain, and F/B ratio should be identical at the new design frequency. However, if diameter scaling is done for the elements, antenna performance will vary slightly with